Health&Safety Manual

Supplement 26.14

Working in Confined Spaces

October 1994

Approved by the ES&H Working Group

_____ **date** _____

Ronald W. Cochran
Laboratory Executive Officer

Working in Confined Spaces*

Contents

1.0 Introduction

1.1 Purpose and Scope

This supplement outlines the responsibilities for individuals who work in confined spaces. It also provides requirements for controlling ignition sources; testing and monitoring the work environment; and isolating, purging, ventilating, entering, and rescuing personnel in confined spaces. Individuals who do not comply with these requirements risk the possibility of injury or death.

Appendix A contains terms and definitions used in this supplement. The other appendices provide additional information and guidance.

1.2 General

A “confined space” is defined as an enclosed area that

- is large enough for an employee to enter and perform assigned work;
- has limited or restricted means of entry or exit; and
- is not designed for continuous human occupancy.

Below are examples of confined spaces that may exist.

- Storm drainpipes
- Sewers
- Vaults
- Storage tanks
- Utility pipelines
- Manholes
- Large vacuum vessels
- Transformer tanks

Confined spaces must be periodically inspected, cleaned, and repaired. Because these spaces are used to store and transport flammable, toxic, corrosive, or oxygen-consuming materials, and because these materials can leak into confined spaces, it is important to enter these areas properly or only as a last resort.

Entry into a confined space occurs when *any* part of an employee's body passes through an opening into a confined space. The cardinal rule for anyone planning to enter a confined space is "never trust your senses." What may look like a harmless situation may become a potential threat, and what may smell strange at first can impair the sense of smell and lull you into a false sense of safety. In fact, some of the deadliest gases and vapors have no odor at all.

The two categories of confined spaces are low-hazard confined space (nonpermit confined space) and high-hazard confined space (permit-required confined space).

- **Low-Hazard Confined Space**—A space that does not contain or, with respect to atmospheric hazards, have the potential to contain a hazard capable of causing death or serious physical harm. Examples of low-hazard confined spaces include a pit or vault that does not have actual or potential hazards, the crawl space of a building with limited means for entry and exit, and a false ceiling plenum.

  Note that in the event of equipment failure, chemical usage, or other incident, a low-hazard confined space may become a high-hazard confined space. For example, use of cleaners, paints, solvents, compressed gas bottles, and welding equipment could turn a low-hazard confined space into a high-hazard confined space.

- **High-Hazard Confined Space**—A confined space that
  - — contains or has the potential to contain a hazardous atmosphere;
  - — contains a material with the potential to engulf an entrant;
  - — has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or a floor that slopes downward and tapers to a smaller cross section; or
  - — contains any other serious safety or health hazard.

  Examples of high-hazard confined spaces include mixing tanks, tank pits, manholes, waste retention tanks, and target chambers.

  Facility personnel (or the space/equipment owner) shall post the appropriate signs in confined spaces judged to be high-hazard spaces. An alternate method for informing employees of these areas may be used but only with the approval of the Hazards Control Department. An area may be designated as a confined space even if no signs are posted.

For information on how to evaluate confined spaces, see Appendix B, "Evaluation Guide for Confined Spaces."

2.0 Requirements/Regulatory Summary

The information provided in this supplement is guided by DOE Order 5483.1A, "Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities," and Code of Federal Regulations, Title 29, Part 1910.146, "Permit-Required Confined Spaces." Other information relevant to this supplement can be found in Supplement 26.13, "General Lockout and Tagout Procedures," of the *Health & Safety Manual* and in the references given in Section 7.0 of this supplement.

3.0 Applicability

This supplement is applicable to all activities that may require LLNL employees, supplemental labor contractors, and other contractors to enter confined spaces. Activities that LLNL personnel perform offsite are governed by the rules and regulations of the offsite organizations involved, provided that those organizations have primary responsibility for health and safety.

4.0 Process for Compliance and Risk Reduction

4.1 Hazardous Atmospheric Conditions

Oxygen-deficient atmospheres, or those that contain combustible or toxic gases and vapors, constitute serious hazards in confined spaces. Normal air contains approximately 20.9% oxygen. An atmosphere is defined as oxygen deficient if it contains less than 19.5% oxygen. If an ignition source is present in or is introduced into an environment that contains flammable gases, solvents, or dust, the atmosphere may burn or explode. Serious injury or death may result when the atmosphere contains even low concentrations of toxic gases (e.g., hydrogen sulfide, sulfur dioxide, or nitrogen dioxide). Everyday operations (e.g., welding, painting, and using solvents or inert gases) that are normally safe can quickly become hazardous when performed in a small, poorly ventilated area. This can change a low-hazard confined space into a high-hazard confined space.

The following criteria define a hazardous atmosphere:

- Flammable gas, vapor, or mist greater than 10% of the lower flammable limit (LFL).
- Airborne combustible dust at a concentration that meets or exceeds its LFL.
- Oxygen concentration less than 19.5% or greater than 23.5%.

- Any airborne contaminant that may expose a worker above an acceptable dose or the permissible exposure limit.
- Any other condition recognized as immediately dangerous to life or health.

4.2 General Controls for Confined Space Entry

4.2.1 Low-Hazard Confined Spaces

Following are the requirements for low-hazard confined spaces:

- Barricades and isolation (if appropriate).
- Electrical equipment (e.g., ground fault circuit interrupters (GFCI) on power hand tools and other electrical equipment). Such equipment must be properly grounded and listed with Underwriters Laboratories.
- Proposed activities must not introduce hazards to the area thereby converting it into a high-hazard confined space. Contact the responsible ES&H team for guidance, if necessary.

4.2.2 High-Hazard Confined Spaces

In addition to the those for low-hazard confined spaces, the following requirements are applicable to high-hazard confined spaces:

- A written permit.
- Mechanical ventilation for actual or potential atmospheric hazards.
- Tests of the atmosphere before and during entry into a confined space by a health and safety technician or other trained person, that is, one who has completed course HS4152 (or equivalent).
- An attendant(s) at the entry point of the confined space.
- Two-way communication with entrants in confined spaces.
- Personal protective equipment deemed necessary by the ES&H team industrial hygienist.
- A harness retrieval system, unless it increases the risk of entry or will not contribute to rescue.
- Rescue team.
- Notification of the area ES&H team technician at least 4 hours before entry into a confined space, except in situations where there is a threat to life or property.

The responsible ES&H team may require notification of the Fire Department emergency dispatcher, including the location and duration of the entry.

If unexpected hazards arise, all employees within a confined space must immediately exit the space. The responsible health and safety technician must then be notified so that he/she can reevaluate the space before re-entry.

4.3 Requirements for Safe Entry into Confined Spaces

No entry will be permitted into a confined space until all precautions noted on the permit have been taken. Thus, the entry supervisor (i.e., the person who signs the permit and authorizes entry into a confined space) must brief entrants, supervisors, and ES&H team members on their responsibilities and the hazards and controls for safe entry. In addition, the proper use of emergency equipment should be demonstrated and the area ES&H technician should be contacted. Consult the ES&H team for guidance on the activities below that will be required for your particular area.

4.3.1 Controlling Ignition Sources

All ignition sources, including lit cigarettes, are prohibited in confined spaces. If sources such as welding or cutting equipment are required, a fire permit must be obtained. When open flames must be used in confined spaces, take extra precautions to ensure adequate ventilation. For a thorough evaluation of a confined space and to obtain a fire permit, call the Emergency Management Division (ext. 2-7595) of the Hazards Control Department.

4.3.2 Isolating the Area

Isolation is the process whereby a high-hazard confined space is removed from service and protected from the release of energy and material into that space.

Open chemical or gas lines within the permit space must be isolated by blanking or blinding (see Appendix A for definition); by misaligning or removing sections of lines, pipes, or ducts; or by using a double-block-and-bleed system. Before beginning work in these spaces, disconnect the lines that may allow hazardous materials to enter or take other precautions to prevent such materials from entering into these areas. For example, take the lines apart, cap the ends, and insert a blank between the flanged connections. Be sure that the blank is strong enough to handle the pressure buildup if a pump is accidentally turned on. As an added precaution, lock out the pumps before entry. Isolate and lock out or tag any other hazardous energy sources (e.g., electrical and mechanical hazards, water lines or pipes, and compressed air to prevent engulfment or injury from impact) to prevent possible injury to entrants. For more information, see Supplement 26.13 (General Lockout and Tagout Procedures) of the *Health & Safety Manual*.

4.3.3 Completing Entry Permits

Confined-space entry permits (see Appendix C) are required before entering a high-hazard confined space. A member of the ES&H team or a person authorized and trained in confined-space testing will complete the permit and conduct the necessary tests for oxygen deficiency, flammability, and toxicity. If a confined space is vacated for more than one hour before the job is completed, the air shall be re-tested to ensure that

conditions have not changed since the original entry. The results of the test shall be noted on the permit.

Once the entry supervisor and the ES&H team member have signed the permit, it should be posted in an easily visible location. The entry supervisor's signature on the permit, along with that of the person authorized to conduct atmospheric testing, is verification that the space is safe to enter. Therefore, he/she shall ensure that

- all appropriate entries are made on the permit;
- tests specified on the permit are conducted;
- all procedures and equipment specified on the permit are in place to permit safe entry into the confined space;
- rescue services and the means for summoning them are available.

Each permit will be valid for the duration of only one work shift unless otherwise noted on the permit. Copies of the permit shall be provided to the industrial hygienist and the ES&H team within five working days. Permits will be retained in the safety team's files for one year; thereafter, they may be destroyed.

4.3.4 Purging and Ventilating Confined Spaces

If a confined space contains sludge or other residue, tests positive for combustible or toxic elements, or indicates an oxygen deficiency or enrichment, purge the area with fresh air and provide positive ventilation both before and throughout entry into the space. Below are some precautions to observe when purging and ventilating a confined space.

- Remove any residue using proper flushing techniques. Starting at the top, flush the space with water or steam to ensure proper cleaning. If entry is required into the space, all personnel must wear suitable protective equipment (see Section 4.3.8).
- Provide a continuous supply of fresh air as close as possible to the work area before and while personnel are working in the confined space. Take care to place the inlet upwind and at least 25 ft away from the confined space and any other potential contaminant (e.g., vehicle exhaust).
- Retest the atmosphere for any hazard(s) in question upon completing the purging and ventilating procedures.
- Continuously perform subsequent tests for oxygen deficiency, flammability, and/or toxicity during entry into the confined space or at intervals frequent enough to ensure a safe atmosphere. Despite a purge, enough toxic substances may still remain in pores and may scale to recreate a hazardous atmosphere.

These precautions may not always be necessary, but purging with air is always mandatory whenever there is an atmospheric hazard or a potential atmospheric hazard.

4.3.5 Testing and Monitoring the Work Environment

Tests for oxygen deficiency or enrichment, flammability, and toxicity must be conducted by a qualified member of the ES&H team or by someone who has completed course HS4152, "Confined-Space Instruments" or equivalent. Because work in confined spaces can create hazardous atmosphere, these tests shall be performed before entry into a confined space, continuously during entry into a confined space, or at intervals frequent enough to ensure a safe atmosphere.

Atmospheric tests must be performed in the following order: oxygen deficiency, flammability and, if necessary, toxicity. Some flammability test instruments require an adequate amount of oxygen to work properly. Use of sampling lines or containers is required to avoid exposure to personnel during the initial testing operations. It is also important to ensure that sampling is representative of the total atmosphere in the space (e.g., sample at different levels within a deep tank). If the prescribed tests indicate a dangerous situation, follow the procedure in Section 4.3.4 and contact the area ES&H team before proceeding.

A variety of instruments is available for determining the oxygen levels and the presence of dangerous air contaminants, but only those approved by the Hazards Control Department may be used. These instruments must be inspected and calibrated by the Industrial Hygiene Laboratories Group (ext. 2-5197) at least every three months, and a sticker with the calibration and due dates for the next calibration should be affixed to the equipment. *Equipment that is out of calibration or that functions erratically shall not be used.*

4.3.6 Attendants

An attendant must be present whenever anyone enters into a high-hazard confined space. He/she must remain outside the entrance, be in communication with the person(s) entering the area, and be ready to summon for help in case of emergency. An effective means of communication between the attendant and the person(s) inside the confined space must be provided whenever the entrant is out of the attendant's sight.

Attendants must read and understand the instructions in Appendices D and E before beginning work in confined spaces.

4.3.7 Rescue Personnel

The Fire Department is the designated rescue team at LLNL. Each member of the team must receive training in the following:

- Rescue procedures for high-hazard confined spaces. Members must practice making rescues in confined spaces at least every 12 months. These drills should be representative of actual situations.

- The use of personal protective equipment. Mechanical retrieval devices shall be available to rescue personnel from vertical-type, high-hazard confined spaces that are more than 5 ft deep.

- The removal of dummies, mannequins, or persons from actual or simulated confined spaces.
- First aid and cardiopulmonary resuscitation.

Each rescue worker must wear a suitable harness attached to one end of a lifeline by a quick-release catch to permit escape if the lifeline breaks, provided that use of the harness will not increase the overall risk of the entry or hinder rescue. The other end of the lifeline shall be secured outside the entry opening to a retrieval system or another fixed point so that retrieval can begin as soon as the rescuer becomes aware that rescue is necessary. The harness and lifeline may also be required even when no respiratory equipment is needed. When entry is through an opening at the top of a confined space, rescue workers must wear a harness-type safety belt that suspends them upright.

Harnesses are available from Stores with approval from the Fire Safety Division of the Hazards Control Department.

If supplied air respiratory protective equipment is required for entry into a confined space, one standby person for every person entering the space must be immediately available outside the space. This person shall have an independent air supply (if applicable) and be fully suited with the required protective clothing, except for the respirator facepiece.

For additional guidance, see Appendix E, "Nonentry Rescue of Personnel in Confined Spaces."

4.3.8 Suitable Protective Equipment

Suitable protective equipment varies depending on the job. Such equipment may include respiratory protection; gloves specifically designed for the material being handled; and protection for the eyes, face, head, and feet. To obtain a respirator or for additional information, call Respirator Services (ext. 27910, Bldg. 324). All other equipment, including acid-resistant apparel, are available from Stores. An annual medical clearance is required for respirator use; call the Health Services Department to schedule an appointment. Contact your ES&H team for additional information, if necessary.

Adequate lighting is required when entering or servicing confined spaces, and flashlights and/or extension lamps approved for the environment must be provided. All portable power tools and lamps used inside confined spaces must be properly grounded and equipped with GFCIs, and electrical or air-operated equipment must be non-sparking. Footwear with exposed nails is prohibited.

4.3.9 Health and Safety Technician Notification

The health and safety technician must be notified at least 4 hours before entry into a high-hazard confined space unless specifically exempted by an operating procedure (OSP or FSP). Notification is not required for emergency situations involving personnel and property. The health and safety technician may audit the procedures for confined-space entry.

4.4 High-Hazard Confined Spaces with Special Circumstances

Some requirements may not be applicable to high-hazard confined spaces if

- the only hazard posed by the confined space is an actual or potential hazardous atmosphere, and
- forced air ventilation alone is sufficient to maintain the confined space safe for entry. An example of such areas is a degreaser maintenance pit—a high-hazard confined space in which forced air ventilation alone may be sufficient to control a potentially hazardous atmosphere.

Special circumstances for high-hazard confined spaces allow for less stringent controls, which can only be approved by the Hazards Control Department using an OSP or approved equivalent written material such as a contractor's operating procedure. A written certificate indicating that the space is safe to enter is required, and a "Certification of Safe Entry" (see example in Appendix F) shall be completed and signed by entrants for each space that qualifies under "special circumstances." See Appendix B for more information on how to qualify a confined space under special circumstances.

4.5 Telecommunication Spaces

Because of the general absence of significant hazards in most telecommunication spaces (vaults), the potential of an accident occurring in such areas is less than that for other types of confined spaces. If you have any question about safety in such areas, contact the area ES&H team or refer to OSP L-36 (Confined Space Entry—Communications Spaces).

4.6 Construction Sites

This supplement applies to construction sites that may have high-hazard confined spaces. Excavations (including trenches) at a construction site may be categorized as confined spaces depending on the depth and physical layout. The ES&H team must conduct an evaluation of such areas on a case-by-case basis to determine whether they are high-hazard confined spaces.

Excavations that are more than 4 ft deep usually qualify as confined spaces. Work within deep excavations may qualify those excavations as high-hazard confined spaces. A deep excavation with a connected sewer line in the space is usually evaluated as a high-hazard confined space because of the potential atmospheric hazard associated with the sewer system. An excavation that is more than 4 ft deep in which a gasoline-powered compactor is used is usually evaluated as a high-hazard confined space, even if ventilation controls are in place, because of the expected buildup of an atmospheric hazard (carbon monoxide) from the compactor exhaust.

Not all excavations (e.g., very shallow excavations, less than 4 ft; or excavations with sloping sides) meet the definition of a confined space and/or a high-hazard confined space. Entry into these spaces would not have to be in accordance with OSHA and LLNL confined space requirements.

5.0 Responsibilities

5.1 Hazards Control Department

The Hazards Control Department shall do the following with the space/equipment owner:

- Identify the hazards for each confined space by examining
  - — past and current uses of the area;
  - — the physical characteristics and configuration;
  - — the potential hazards in the area, including oxygen deficiency, flammability, or toxicity;
  - — the biological and mechanical hazards in the area.
- Perform an initial evaluation of the hazards associated with the confined space. Each hazard shall be examined with respect to the scope and magnitude of the hazard, the likelihood of the occurrence of the hazard and the related consequences, the potential for changing conditions/activities, strategies for hazard control, and the impact on the need for emergency response.
- Review pre-operational activities of confined spaces and discuss with entrants the potential hazards, the appropriate safeguards, and the personal protective equipment required.
- Re-evaluate the classifications of confined spaces annually or when changes in a work area may affect the space. The space/equipment owner shall be provided with documentation for any change.

The Hazards Control Department shall approve the confined-space entry permit with the entry supervisor. In addition, the Department shall do the following:

- Develop programmatic procedures and provide employees with regulatory interpretations relative to confined space entry.
- Provide technical guidance on the procurement and operation of confined-space equipment.
- Approve the procurement of equipment used to enter confined spaces.
- Assist in monitoring and evaluating airborne contaminants, particularly toxics.

- Evaluate physical hazards, including thermal effects (heat and cold), noise, and vibration.
- Develop special procedures for handling hazards created by unique operational activities, including procedures for
  — cleaning and decontaminating work areas and equipment;
  — performing hot-work operations in double-walled vessels;
  — inerting an atmosphere.

  Entrants and attendants must follow these procedures.
- Provide the space/equipment owner with specifications for posting the entrances to confined spaces.
- Assist with the development and performance of training courses.
- Maintain copies of all confined-space entry permits.
- Maintain a database of low- and high-hazard confined spaces, and provide the information in that database upon request.
- Regularly audit compliance with confined-space entry and testing procedures.
- Issue and monitor compliance with hot-work permits for operations performed in confined spaces, as appropriate.

5.2 Entry Supervisors

Entry supervisors are responsible for all personnel who enter or work in confined areas. In addition, they shall also do the following:

- Complete the appropriate training (see Section 6.0, Table 1).
- Ensure that individuals under their cognizance receive the proper training for confined space entry, including medical examinations when applicable.
- Provide the Hazards Control health and safety technician with advance notice of planned, confined-space entry work so that arrangements can be made for the necessary equipment and testing. Notification should be at least 4 hours in advance of the expected entry, except in situations where there is a threat to life or property.
- Perform pre-operational review activities in confined spaces and discuss with entrants the potential hazards, the appropriate safeguards, and the personal protective equipment required.
- Be knowledgeable of the hazards one may encounter upon entering a confined space, including the mode, signs, symptoms, and consequences of exposure.

- Check that the necessary procedures, practices, and equipment used for safe entry into confined spaces are in effect before authorizing entry or re-entry.
- Sign the confined-space entry permit after the Hazards Control Department has signed it. These signatures officially allow entry into confined spaces and verify that all actions and conditions necessary for safe entry are provided and will be maintained.
- Ensure that operations comply with the terms and conditions on the permit.
- Ensure that transfer is made to another authorized supervisor whenever the responsibility for a permit space entry changes, and that the terms and conditions of the permit are maintained.
- Take appropriate measures to remove unauthorized personnel who are in or about to enter confined spaces.
- Cancel the permit authorization whenever unacceptable conditions exist or upon completing permitted activities. If unexpected hazards arise, all employees must leave the area immediately and notify the responsible health and safety technician so that he/she can re-evaluate the space before re-entry.
- Provide copies of the permit upon completing the work to organizations listed on the permit.
- Maintain copies of all confined-space entry permits issued under their cognizance.
- Audit compliance with procedures for confined space before each entry.

5.3 Personnel Entering Confined Spaces (Entrants)

Individuals who work in confined spaces shall do the following before entering:

- Complete the appropriate training (see Section 6.0, Table 1).
- Confer with space/equipment owners to identify any modification to the space, and review the hazards and safeguards associated with confined-space entry to determine if additional evaluations are necessary.
- Ensure that the equipment used in confined spaces is properly isolated. With assistance from Plant Engineering and the Hazards Control Department, lock out equipment in accordance with lockout/tagout operating procedures.
  NOTE: Entrants may have to complete part or all of the isolation or equipment preparation procedures in cases where the individual responsible for the equipment is unable to do so.

- Be knowledgeable of the hazards associated with confined spaces; recognize the signs and symptoms of exposure, including behavioral effects; and understand the consequences of exposure to the hazards in these spaces.
- Maintain an awareness of the appropriate personal protective equipment and its proper application.
- Read the confined-space entry permit, if one is required, and agree to accept and abide by its conditions.
- Maintain contact with the attendant in charge of the confined space.
- Notify the attendant of a self-initiated evacuation of a confined space.
- Exit a confined space if
  - — instructed by an attendant;
  - — an alarm is activated;
  - — danger is perceived.
- Stop work if conditions can adversely affect entrants or if the equipment has been changed. Advise the entry supervisor of these conditions.
- Clean up the area upon completing work, and return any equipment that was checked out the same day.

5.4 Attendants

Attendants must comply with the requirements below for confined space entry. In cases where they may serve as atmospheric monitors, attendants shall adhere to the requirements in Section 5.5.

- Complete the appropriate training (see Section 6.0, Table 1).
- Follow the guidelines in Appendix D, "Primary Responsibilities for Attendants," and Appendix E, "Non-Entry Rescue of Personnel In Confined Spaces."
- Do not perform other tasks that might interfere with your primary duty of monitoring and protecting entrants.
- Provide standby assistance to entrants within confined spaces. *An attendant shall only leave the confined-space entry point if he/she is relieved by another attendant or to get help during an emergency.*
- Be knowledgeable of the hazards associated with confined spaces; recognize the signs and symptoms of exposure, including behavioral effects; and understand the consequences of exposure to the hazards of these spaces.
- Monitor inside and outside the area for any change or condition that could adversely affect entrants.

- Initiate evacuation and emergency procedures.
- Maintain continuous and effective contact with entrants.
- Direct occupants to leave a confined space when you observe irregularities.
- Provide rescue and/or medical personnel with information about the hazards in the confined space.
- Sign the confined-space entry permit, if one is required, and agree to accept and abide by its conditions.
- Take the necessary measures to remove unauthorized persons who are in or about to enter confined spaces.

5.5 Atmospheric Monitoring Personnel

Atmospheric monitoring personnel shall do the following:

- Complete the appropriate training (see Section 6.0, Table 1).
- Perform gas testing of equipment before each use in accordance with the manufacturer's recommendations for that equipment to ensure that it functions properly. This includes "field test."
- Perform the tests indicated on the confined-space entry permit, including any additional tests that may be necessary. Record the results on the confined-space entry permit.
- Ensure that the confined-space monitoring procedures test for atmospheric contaminants that are representative of all areas of confined spaces.
- Report to and work with the Hazards Control Department, entry supervisor, space/equipment owner, and entrants to resolve any issue pertaining to the gas-test results.
- Pay particular attention to contaminants that may be absorbed through the skin.

5.6 Space/Equipment Owner

With assistance from Plant Engineering and the Hazards Control Department, the space/equipment owner shall do the following:

- Shut down and prepare equipment that is used in confined spaces.

- Isolate and lock out or tag equipment in accordance with established operating procedures. If the space to be entered affects or can be affected by interconnecting or adjacent equipment or personnel, coordinate the equipment preparation and isolation with the owners and have them endorse (by signature) the confined-space entry permit.

In addition, the space/equipment owner shall do the following:

- Complete the appropriate training (see Section 6.0, Table 1).
- Maintain a list of low- and high-hazard confined spaces in the area.
- Review the confined space information provided by the ES&H team industrial hygienist; submit corrections for hazards not mentioned or accounted for in the identification and evaluation survey, as appropriate.
- Post confined spaces with the appropriate signs, as necessary. Consult the ES&H team industrial hygienist for sign specifications.
- Notify the ES&H team industrial hygienist about significant modifications to confined spaces that may impact classification and/or procedures for entry.
- Be apprised of and identify operations and activities in the area that may potentially impact entry into confined spaces.
- Consult with the requester of the confined-space entry permit to determine its current status and if any modification has been made to the confined space; sign the confined-space entry permit.
- Notify the ES&H team industrial hygienist if you have changed responsibilities.
- Monitor operational conditions and revoke permits if unsafe conditions or practices arise.
- Take appropriate measures to remove unauthorized personnel who are in or about to enter confined spaces.

5.7 LLNL Fire Department Personnel

The Fire Department shall do the following:

- Complete the appropriate training for rescue/recovery personnel (see Section 6.0, Table 1).
- Assist in the development and implementation of rescue/recovery procedures for confined-space entry.
- Conduct rescue drills with LLNL personnel on a scheduled basis but not less than once per year.

- Tour LLNL as appropriate to maintain continued familiarity with the premises; review confined spaces with emphasis on size and configuration.

5.8 Health Services Department

The Health Services Department shall provide the following:

- Medical care during emergency response, as appropriate.
- Pre-placement examinations. A pre-placement exam is required for employment at LLNL. This examination will evaluate physical capabilities in relation to the prospective job. The Department shall be notified of all job transfers to determine if further medical evaluation is needed.

5.9 Plant Engineering

Plant Engineering shall do the following with assistance from the Engineering and Construction Department, construction inspectors, and LLNL-designated representatives monitoring contract personnel:

- Complete the appropriate training (see Section 6.0, Table 1).
- Contact the ES&H team industrial hygienist for a pre-operational review of contractor activities before initiating confined-space operations.
- Review the information on the contractor's confined-space entry permit and sign the "Approval" section. A signature officially allows issue of the permit and verifies that all actions and conditions necessary for safe entry into a confined space are provided and will be maintained.
- Debrief contractors regarding any hazard that was encountered or created during the operation and of the appropriate corrective action upon concluding the entry.

5.10 Procurement Department

The Procurement Department shall do the following with assistance from Plant Engineering, the Engineering and Construction Department, LLNL-delegated representative, and the ES&H team industrial hygienist:

- Ensure that prospective contractors bidding on LLNL contracts are informed that confined-space operations are involved in the scope of the work. Contractor work practices and procedures shall incorporate all applicable regulatory requirements. Knowledge of the content of applicable regulatory standards should be considered fundamental for any contractor who proposes to engage in confined-space operations at LLNL.
- Ensure that procurement requisitions for confined-space safety equipment are approved by the ES&H team industrial hygienist.

6.0 Training

All personnel (e.g., workers, attendants, or emergency services personnel) involved in confined-space activities must complete the required training in Table 1, including course HS4150 (Confined-Space Entry) before entering a confined space. Contractor personnel must complete equivalent training and provide evidence of the training upon request. Retraining is required every two years and must be documented in the Laboratory Repository of Completed Courses (LROCC). Atmospheric monitors must complete course HS4152 (Confined-Space Instruments).

Depending on the nature of the entry into a confined space, other required training may include courses HS1620 (Standard First Aid), HS4610 (Air-Purifying Respirators—General Training), HS4620 (Air-Line Respirators—General Training), and HS4630 (Self-Contained Breathing Apparatus). Additional training needs are identified by the area ES&H team.

Employees who fail to follow or are unfamiliar with confined-space entry procedures shall have their confined space authorization immediately suspended. These employees will require retraining before any entry into a confined space is allowed.

Table 1. Training requirements for high-hazard confined space work*

Responsible person	HS4150	HS4152	HS5245	HS1620 and HS1640	HS4610/11 HS4620/21 HS4630/31
Managers/Supervisors of Personnel entering confined spaces	o	o	o		
Space/Equipment Owner where confined space is located	o	o	o		
Atmospheric Monitoring Personnel	X	X			o
Entry Supervisors	X	X	o	o	o
Entrants	X	X	o	o	o
Attendants	X	X	o	o	o
Rescue/Recovery Personnel	X	X	X	X	X

*** See the current *LLNL Course Catalog* for complete course descriptions of the following:**

HS1620, "Medic First Aid"

HS1640, Cardiopulmonary Resuscitation (CPR)"

HS4150, "Confined-Space Entry" (Biennial refresher training required)

HS4152, "Confined-Space Instruments" (Biennial refresher training required)

HS4610, "Basic Respirator Training"

HS4611, "Air-Purifying Respirators—Specific Training"

HS4620/21, "Air-Line Respirators—Specific Training"

HS4630/31, "Self-Contained Breathing Apparatus"

HS5245, "Lock and Tag Procedure"

o = Recommended

X = Required

7.0. Supporting References and Standards

American National Standards Institute (1989), "Safety Requirements for Confined Spaces," ANSI Z117.1-1989, ANSI, New York.

California Code of Regulations, Title 8, *Industrial Relations Safety Orders.*

Code of Federal Regulations, Title 29, Section 1910.146, *Permit Required Confined Spaces for General Industry; Final Rule*, Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 29, Section 1910.268(o), *Telecommunications; Underground lines*, Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 29, Section 1926.21(b), *Safety Training and Education*, Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 29, Section 1926.21(6)(i), *Safety Training and Education*, Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 29, Subpart P (Excavations), Section 1926.651, *General Requirements*, Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, DC.

Operational Safety Procedure L-36, *Confined Space Entry—Communication Spaces*, Lawrence Livermore National Laboratory, 1993.

Procedures for Confined Space Entry, Sandia National Laboratory, Livermore, California, 1993.

Appendix A

Terms and Definitions

acceptable entry conditions	The conditions that must exist in a permit space to allow entry and ensure that employees involved with a high-hazard confined space entry can safely enter into and work within the space.
attendant	An individual stationed outside one or more permit spaces to monitor authorized entrants. He/she performs all attendant's duties assigned in the employer's permit space program.
authorized entrant	An employee authorized by the employer to enter a permit space.
blanking or blinding	The absolute closure of a pipe, line, or duct by fastening a solid plate (e.g., a spectacle blind or skillet blind) that completely covers the bore and is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.
confined space	A space that (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and (3) is not designed for continuous employee occupancy.
confined space program	The overall program for controlling and, where appropriate, protecting employees from permit space hazards and for regulating employee entry into permit spaces.
double block and bleed	The closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.
emergency	Any occurrence (including any failure of hazard control or monitoring of equipment) or internal or external event to the permit space that could endanger entrants.

engulfment	The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.
entry	The action by which a person passes through an opening into a high-hazard confined space. Entry includes ensuing work activities in that space, and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.
entry permit	The written or printed document that is provided by the employer to allow and control entry into a permit space.
entry supervisor	The person (e.g., the employer, foreman, or crew chief) responsible for • determining if acceptable entry conditions are present in a permit space where entry is planned; • authorizing entry and overseeing entry operations; • terminating entry. An entry supervisor also may serve as an attendant or authorized entrant, as long as that person is trained and equipped for each role he/she fills as required by this supplement. Also, the duties of the entry supervisor may be passed from one individual to another during an entry operation.
hazardous atmosphere	An atmosphere that may expose employees to the risk of death, incapacitation, impairment of the ability to self-rescue (i.e., escape unaided from a permit space), injury, or acute illness from one or more of the following causes: • Flammable gas, vapor, or mist exceeding 10% of its lower flammable limit (LFL). • Airborne combustible dust at a concentration that meets or exceeds its LFL. NOTE: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 ft or less. • Atmospheric oxygen concentration below 19.5% or above 23.5%.

- Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in a DOE-mandated health and safety standard. NOTE: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.
- Any other atmospheric condition that is immediately dangerous to life or health. Other sources of information (e.g., material safety data sheets that comply with the Hazard Communication Standard, 29 CFR 1910.1200, published information, and internal documents) can provide guidance on establishing acceptable atmospheric conditions for air contaminants that OSHA has not yet determined a dose or the permissible exposure limit.

high-hazard confined space (permit space)

A confined space that has one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere.
- Contains a material that has the potential to engulf an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section.
- Contains any other recognized serious safety or health hazard.

hot-work permit

The employer's written authorization to perform operations capable of providing a source of ignition (e.g., riveting, welding, cutting, burning, and heating).

immediately dangerous to life or health

Any condition that poses an immediate or delayed threat to life, or that would cause irreversible adverse health effects, or that would interfere with an individual's ability to escape unaided from a permit space. NOTE: Some materials (e.g., hydrogen fluoride gas and cadmium vapor) may produce immediate transient effects that, even if severe, may pass without medical attention but are followed by sudden, possibly fatal, collapse 12–72 hours after

	exposure. The victim “feels normal” from recovery from transient effects until he/she collapses. Such materials in hazardous quantities are considered to be “immediately” dangerous to life or health.
inerting	Displacement of the atmosphere in a permit space by a noncombustible gas (e.g., nitrogen) to such an extent that the resulting atmosphere is noncombustible. NOTE: This procedure produces an oxygen-deficient atmosphere that is immediately dangerous to life or health.
isolation	The process by which a permit space is removed from service and completely protected against the release of energy and material into that space by means such as • blanking or blinding; • misaligning or removing sections of lines, pipes, or duct; • using a double-block-and-bleed system; • locking or tagging out all sources of energy; • blocking or disconnecting all mechanical linkages.
line breaking	The intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.
low-hazard confined space	A confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.
oxygen-deficient atmosphere	An atmosphere containing less than 19.5% oxygen by volume.
oxygen-enriched atmosphere	An atmosphere containing more than 23.5% oxygen by volume.
permit system	The written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.
prohibited condition	Any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

rescue service or team	Personnel designated to enter confined spaces to rescue employees from permit spaces. At the Laboratory this is the LLNL Fire Department.
retrieval system	The equipment (including a retrieval line, chest or full-body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.
testing	The process of identifying and evaluating the hazards of a permit space that entrants may encounter. Testing includes specifying the tests to be performed on the permit space. NOTE: Testing enables employers to devise and implement adequate control measures for protecting authorized entrants and for determining if acceptable entry conditions are present immediately before and during entry.

Appendix B

Evaluation Guide for Confined Spaces

Appendix C

Confined Space Entry Permit

Appendix D

Primary Responsibilities for Attendants

Attendants must carefully read, understand, and be thoroughly familiar with the instructions in this appendix before beginning work in confined spaces.

Following are the primary responsibilities for attendants:

1. Ensure the safety of personnel working in vessels or confined spaces.
2. Maintain an accurate count of all persons working in confined spaces.
3. Maintain the conditions and requirements listed on the confined-space entry permit.
4. Notify everyone to evacuate the confined space if you observe a hazardous condition.
5. Dial 911 for both the Livermore site and Site 300 to obtain help if an emergency arises. Do not attempt to enter the confined space during an emergency. If possible, an attendant may rescue a victim from a confined space using a retrieval system and without additional help if such rescue does not require entering the space.
6. Provide the rescue team incident commander with the confined-space entry permit, including any information on the events leading up to the emergency.

> NOTE: The circumstances and conditions of the job will determine the safety requirements. However, the steps below are basic to all jobs.

7. Maintain effective and continuous contact with entrants.
8. Do not leave your assignment while personnel are inside the confined space, except to get help in an emergency. If other duties require you to leave your assignment, have all personnel evacuate the space.
9. Consult your supervisor if you have any questions regarding the job.
10. Be alert. Try to anticipate and prevent any condition that would be hazardous.
11. Prevent the fouling of air lines and/or lifelines.
12. Make sure that you have been trained in the proper use of respiratory equipment or lifelines if required use them.
13. Clean and return special equipment to its original location upon completing the job.

Appendix E

Nonentry Rescue of Personnel in Confined Spaces

Persons who have tried to rescue individuals from confined spaces have themselves become victims because of failure to follow proper procedures. Thus, it is essential that all persons involved with the rescue of personnel from confined spaces know exactly what to do in such situations. If possible, an attendant may rescue a victim from a confined space using a retrieval system and without additional help if the rescue does not require the attendant to enter the space.

A person who has collapsed or appears to be having difficulty while working in a confined space could be experiencing a heart attack or other illness. In such instances,

1. Dial 911 for both the Livermore site and Site 300 to obtain help. Do not attempt to enter the confined space during an emergency.
2. Attempt to retrieve the person(s) from outside the confined space using a harness retrieval system or other equipment. Do not enter the confined space or attempt a rescue unless designated by the incident commander.
3. Using the retrieval system, remove the victim from the area immediately.
4. Render whatever first aid you are qualified to provide once the victim is outside the space until medical help arrives. Immediately check for injuries and treat lifethreatening conditions.

   NOTE: The attendant shall assist the Fire Department rescue team upon arrival.

Appendix F

Example of Certification of Safe Entry Form

All answers to the following questions must be "Yes" to allow entry. A completed copy of this sheet must be sent to the ES&H team industrial hygienist.

Date: _____

Confined space number / Location: _____

	Yes
1. Has the ES&H technician been notified at least 4 h in advance (unless exempted by written procedure)?	____
2. Is it safe to remove the entrance cover?	____
3. Is a temporary barrier in place to protect the opening?	____
4. Is the confined space atmosphere for the following tested in the order listed and found to be safe:	
• Oxygen level (approximately 21%)?	____
• Lower flammable limit (LFL) of flammable gases or vapors (less than 10%)?	____
• Carbon monoxide level (less than 5 ppm)?	____
• Toxic air contaminants (approximately background or zero)?	____
If any level or oxygen deficiency is measured, entry is not allowed. Contact the health and safety technician for assistance.	
5. Do the work areas where employees will be within the space have direct, forced ventilation?	____
6. Was the air supply for the forced air ventilation obtained from a clean source?	____
7. Will the atmosphere within the confined space be tested continuously or periodically (at least every hour) to ensure that hazardous atmosphere is not developing? (Does the personal gas-alarm monitor meet established requirements?)	____
8. Does the employee entering the space have a certificate?	____

I certify that this confined space is safe for entry.

_____ _____

Entrant's Signature Entrant's Signature

_____ _____

Print name Print name